A reclassification of Italian inner areas: evidence from Sicily

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Abstract

Since 2014, the National Strategy for Inner Areas (NSIA) has categorized Italian municipalities based on their distance from "poles", defined as centres that provide some essential services (at least one hospital with an emergency room, secondary schools, a train station). The "inner areas" (IA) are municipalities located at a certain distance from the poles. The NSIA model has been praised in scientific debates, but it appears to be strongly focused on the provision of the three indicated services. The model neglects demographic, economic, and infrastructural accessibility differences that characterize territories and guide development policies. In this work, we aim to provide a more nuanced representation of the phenomenon and municipalities, going beyond the availability of the three NSIA services. In particular, we propose a reclassification of the IA by selecting some indicators related to two thematic areas: a) accessibility to infrastructure and services, b) demographic and socioeconomic context. Dimensionality reduction is achieved through principal component analysis. The reclassification is applied to municipalities in Sicily (Italy) together with the representation of their demographic profile. The objective of this work is to reclassify Sicilian municipalities based on their degree of peripherality, infrastructural scarcity, and demographic and economic difficulties. The proposed classification is intended as an alternative to NSIA and is not competitive. However, our method is entirely different, based on a different theoretical premise and a greater number of indicators. The initial results show a more detailed division of areas compared to the one that emerged from NSIA. Specifically, it is possible to highlight the critical issues of municipalities in a more precise manner. This could be of great help in developing targeted intervention plans, minimizing waste.

Keywords: Inner Areas; Reclassification; NSIA; Depopulation; Italy

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1. Introduction

A large part of the Italian territory is characterized by a spatial organization based on “minor centres”, often small in size, which in many cases are not able to guarantee residents the accessibility to essential services. These areas have been defined as “inner areas” (IA) by the National Strategy for Inner Areas (NSIA) in 2014 and are small municipalities far from centres offering basic services (Figure 1). Since the 1950s, a significant part of the IAs has undergone a process of marginalization which, first of all, has exhibited an intense phenomena of de-anthropization: a) reduction in the population and demographic ageing; b) reduction in employment and in the degree of exploitation of territorial capital (Barca et. al., 2014). Secondly, this process has brought about a progressive quantitative and qualitative reduction of the local offer of public, private, and collective services – that is, the services which define the quality of citizenship in the contemporary European society (Vendemmia et al., 2021).

NSIA categorizes all Italian municipalities on the basis of their distance from the centres providing services, defined as “poles”, the identification of which constitutes the first step of the classification process. Poles are defined as municipalities able to simultaneously offer the presence of:

1. at least one hospital with an emergency department;
2. good offer of secondary schools;
3. one railway station (Italian silver level).

The other municipalities are then classified according to the travel time residents must spend to reach the nearest service provider centre:

1. Belt areas, travel time under 20 minutes;
2. Intermediate areas, between 20 and 40 minutes;
3. Remote areas, between 40 and 75 minutes;
4. Ultra-remote areas, with a travel time above 75 minutes.

Figure 1 NSIA classification of the Italian municipalities. Source: Agenzia per la Coesione Territoriale (2014, p. 17).

Inner areas are defined as all the municipalities which travel time is above 20 minutes: i.e. intermediate, remote, and ultra-remote areas. The distances considered are the road distances, measured in terms of time with respect to ideal travel conditions. According to this classification inner areas cover 60% of the national territory, 52% of all municipalities, and 22% of the Italian population (De Matteis, 2013). The municipalities have recently been reclassified. The new classification was published at the beginning of 2022. The method used has not changed. After identifying the poles again based on the same criteria, the distances were recalculated with more advanced GIS methods and more accurate data.

NSIA has, as the ultimate objective, the reversal of the demographic trend, both in terms of number of residents and in terms of composition by age and birth rate. Therefore, the demographic situation is considered as the central issue to be addressed in formulating an economic development plan for IAs. Despite this, no demographic indicator is considered to identify IAs affected by chronic population drain. The model proposed by NSIA has received appreciation in the scientific debate, both for the proposed classification work and for the particular definition of "inner area". At the same time, despite the extensive premises accompanying the NSIA processing, it appears to be strongly focused on the provision of the three services indicated. The same classification model proposed, based solely on distances from the municipalities considered "poles" determines the categorization of the whole national territory, neglecting the differences in terms of demographic, economic conditions, and infrastructural accessibility. Moreover, there remain some inconsistencies such as that, while recognizing that inland areas are affected by the exodus of young people, NSIA still adopts indicators such as health services, which are of little significance in terms of improving the supply of services that create opportunities to prevent this.

Here, we intended to provide a more articulated reading of the phenomenon in question, arriving at a representation of the municipalities capable of going beyond the availability of the three services of general interest (schools, hospitals, stations), considered by the NSIA as essential to ensure territorial cohesion and the development of disadvantaged areas. The objective of this work is the reclassification of IAs (with a specific application to the Sicilian municipalities) with respect to the degree of peripherality, infrastructural scarcity, and demographic and economic distress. The classification proposed is intended to be non-competing, rather alternative to that of NSIA. It should be clarified, however, that our method is completely different from the NSIA one, because it is based on an original workflow and on a different theoretical premises, as well as on a much higher number of indicators. Further, we provide a sort of demographic profile of the Sicilian municipalities to stress the importance of the population structure and dynamics in the identification of the areas suffering from young and active forces drain.

The remainder of the work is structured as follows: section 2 illustrates the methodology implemented; section 3 presents the geographical context of application and elaborates on the demographic profile of the Sicilian municipalities; section 4 provides the results of the reclassification procedure; section 5 reports the discussions and conclusions of the work.

2. Methodology

We propose a reclassification of the NSIA inner areas by selecting several indicators that refer to two large and independent thematic areas: a) accessibility to infrastructures and opportunity to reach physical or digital services; b) demographic and economic context (Battaglini, 2014; Del Colle, Esposito, 2000). It is worth mentioning that the availability of a complete school offer is one of the conditions chosen by NSIA for the identification of poles. After noting that schools were well distributed throughout the regional territory, we decided not to take this aspect into consideration. Distances have been extracted from the distance matrices provided by Istat, which report the distances

in minutes between all the Italian municipalities. The analysis of the Italian road network has been accomplished via TomTom Multinet 2013, a road map. The municipalities entirely located in the Sicilian isles (i.e. Lipari, Malfa, Salina, Leni, Pantelleria, Lampedusa e Linosa, Ustica, Favignana) have been omitted, due to the inherent impossibility in the distances computation. The reduction of the dimensionality in our dataset and the definition of the two thematic areas have been carried out implementing a principal component analysis (PCA) (Bartolomew, 2008; Del Colle & Esposito, 2000; Di Franco, 2017; Di Franco & Marradi, 2003).

3. Sicily: The demographic profile of the Sicilian municipalities in relation to the NSIA classification

The world-case application of the proposed reclassification is represented by the southern Italian island of Sicily. According to the 2020 NSIA classification (Dipartimento per le politiche di coesione - Mappa Aree Interne 2020 (governo.it)), the Sicilian IAs include 310 of the 390 municipalities of the region (areas coloured in shades of green in Figure 2).

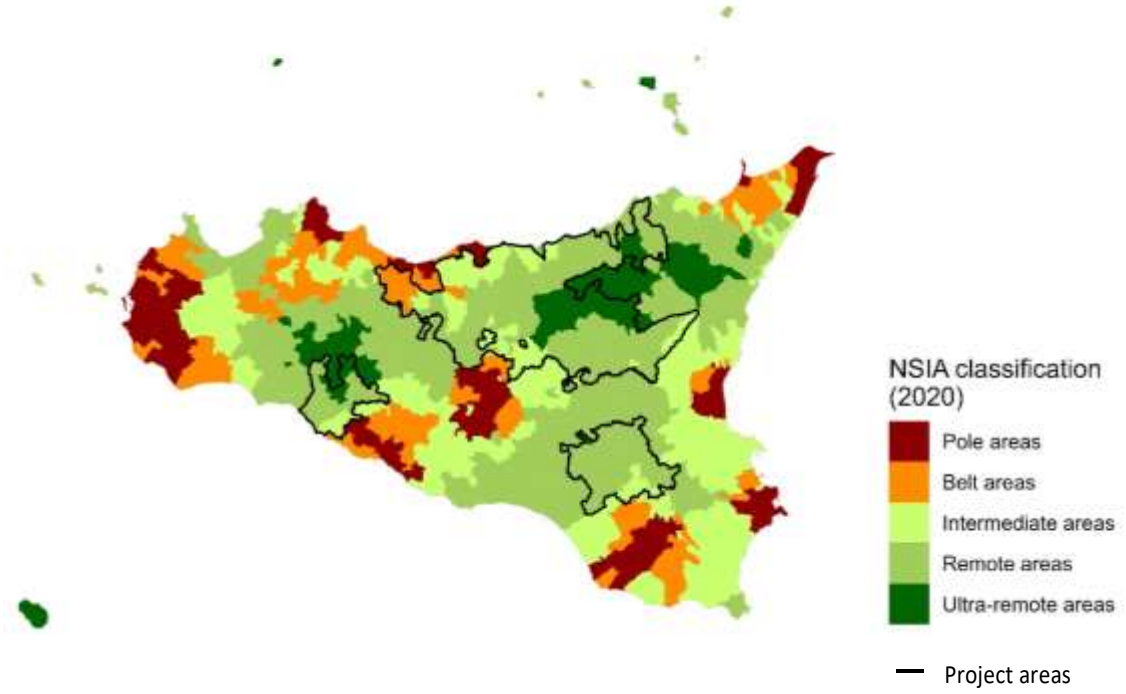

Figure 2 NSIA classification of Sicilian municipalities updated in 2020. Source: authors' elaboration on NSIA data. Note: for ease of representativeness, some of the Sicilian isles have been removed from the current figure.

Among them, 34 municipalities have been classified as ultra-remote areas and are mainly located in the north-eastern and western inland areas (without considering the minor isles). Between 2014 and 2022, SNAI selected 6 project areas (PAs) among the Sicilian IAs: Calatino, Madonie, Nebrodi, Terre Sicanie, Valle del Simeto – Etna and Troina[5]. The PAs are groups of municipalities, intended as pilot areas,

[5] The Sicilian PAs include the following municipalities:
- Calatino: Caltagirone, Grammichele, Licodia Eubea, Mineo, Mirabella Imbaccari, San Cono, San Michele di Ganziaria, Vizzini;
- Madonie: Alimena, Aliminusa, Blufi, Bompietro, Caccamo, Caltavuturo, Castelbuono, Castellana Sicula, Collesano, Gangi, Geraci Siculo, Gratteri, Isnello, Montemaggiore Belsito, Petralia Soprana, Petralia Sottana, Polizzi Generosa, Pollina, San Mauro Castelverde, Scillato, Sclafani Bagni;

where targeted actions to counter territorial marginalization are to be implemented. For each PA, a framework program agreement (ApQ) is established, outlining all the interventions to be carried out, the allocated financial resources, the scheduling of activities, and the expected results associated with each intervention (Tantillo & Lucatelli, 2018).

IAs together account for the 75.64% of the whole area of the region, while hosting almost half (47.84%) of the total residing population in 2020 (Table 1). Similar figures highlight the importance of IAs both in geographical and demographic terms.

Table 1 Territorial area and population counts in Sicilian NSIA areas. Percentage values in brackets. Source: authors' elaboration on NSIA data.

NSIA classification	Geographic area (km^2 – 2019)	Total population (2020)
Pole areas	2882.30 (11.16)	1758272 (36.38)
Belt areas	3409.22 (13.20)	763426 (15.79)
Intermediate areas	6584.51 (25.50)	1151185 (23.82)
Remote areas	10749.76 (41.61)	1059083 (21.91)
Ultra-remote areas	2206.71 (8.53)	101739 (2.11)
Sicily	25832.54 (100.00)	4833705 (100.00)

In Sicily during the last decades, the economic globalization and the expansion of urban areas have aggravated the contrast between the coastal metropolitan cities which offer public and private services (Palermo, Catania, and Messina) and the depopulation of inland areas, historically characterized by the presence of agricultural activities (Scrofani & Novembre, 2015), as illustrated in Figure 3. These areas often are inaccessible and sometimes unknown to foreigners and suffer from economic and cultural marginalities. The census data from the last three decades highlighted that the local population has shown a progressive tendency to concentrate along the Northern and Eastern coasts, especially in the vicinity of the large metropolitan centres (Bitonti et al., 2023). This trend has accentuated the differences between urbanized areas, and inland areas, which are even more isolated, scarcely populated and almost completely lacking in basic services.

- Nebrodi: Alcara Li Fusi, Caronia, Castel di Lucio, Castell'Umberto, Frazzanò, Galati Mamertino, Longi, Militello Rosmarino, Mirto, Mistretta, Motta d'Affermo, Naso, Pettineo, Reitano, San Fratello, San Marco d'Alunzio, San Salvatore di Fitalia, Sant'Agata di Militello, Santo Stefano di Camastra, Tortorici, Tusa;
- Terre Sicane: Alessandria della Rocca, Bivona, Burgio, Calamonaci, Cattolica Eraclea, Cianciana, Lucca Sicula, Montallegro, Ribera, San Biagio Platani, Santo Stefano Quisquina, Villafranca Sicula;
- Valle del Simeto - Etna: Adrano, Biancavilla, Centuripe.
- Troina: Agira, Assoro, Calascibetta, Catenanuova, Cerami, Gagliano Castelferrato, Leonforte, Nicosia, Nissoria, Regalbuto, Sperlinga, Troina, Valguarnera Caropepe, Villarosa.

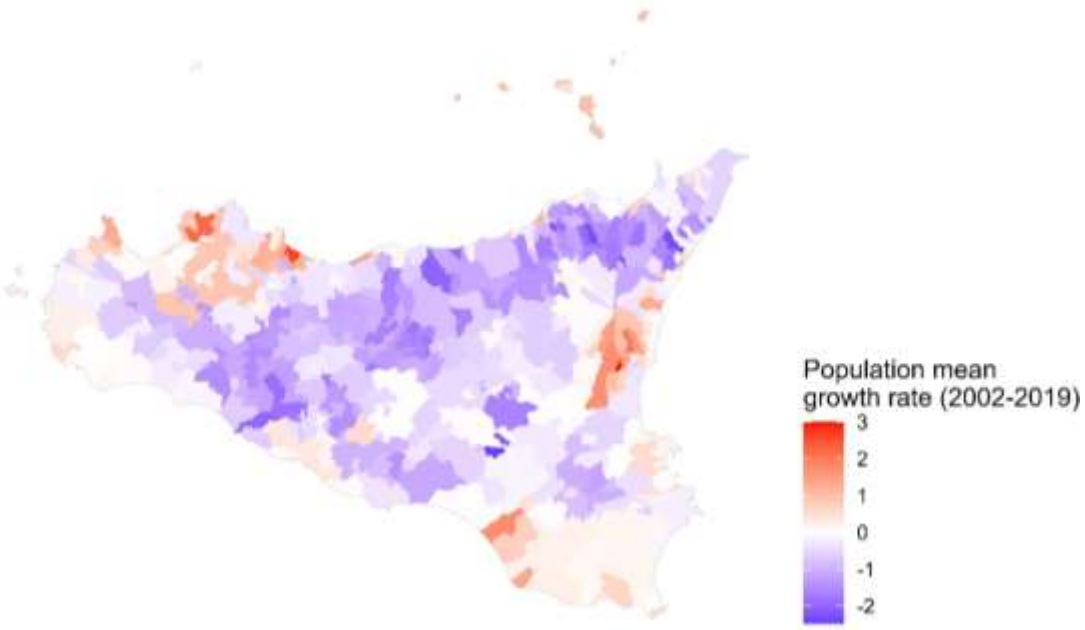

Figure 3 Population mean growth rate during the period 2002-2022 in Sicily. Source: authors' elaboration on Istat data. Note: for ease of representativeness, some of the Sicilian isles have been removed from the current figure.

According to our elaborations based on Istat data, just the 20.5% of the Sicilian municipalities has registered a positive population mean growth rate in the period 2002-2022 (i.e. 80 municipalities out of 390). Moreover, dividing into age classes the population residing in each municipalities, it is possible to assess that the areas recording an average growth in population between 2002-2022 have, on average, a higher share of young and adult people in 2022 compared to the areas registering population loss (Table 2). This means that the municipalities affected by depopulation have been losing the active (or active in the short run as regard young persons) part of the population. In other terms, less and less working-age individuals are left to support the increasing share of elderly. Areas losing and gaining population over time not always coincide with IAs and a heterogeneous dynamics is recorded also across AIs (Barca et al., 2014). In our opinion, the consideration of a similar "demographic distress" should be considered in the definition of IAs.

Table 2 Population structure of Sicilian municipalities in 2022 based on the population mean growth rate for 2002-2022. Source: authors' elaborations on Istat data.

Population mean growth rate (2002-2022)	Young people [0-19]	Adult people [20-65)	Old people [65+)
Positive	18.9%	59.8%	21.2%
Negative	16.6%	57.7%	25.6%

Another relevant dimension to consider is, in our thoughts, the comparison between the temporal dynamics and the static situation (e.g. referring to a single year) of the demographic change involving the different municipalities. The areas experiencing systematic demographic drain across time should be considered in different terms with respect to areas affected by contingent loss of active parts of their population. The mean growth rates between 2002 and 2022 of different dependency indices, along with their values recorded in 2022 illustrated in Figure 4 highlight the discrepancies between the temporal

variation (subfigs.4.a-c-e) and the static values (subfigs.4.b-d-f) of the same indicator. The values reported in the right-hand side maps refer to 2022 and highlight a higher demographic burden for people in the working-age class in IAs and especially in PAs (contoured by black solid lines).

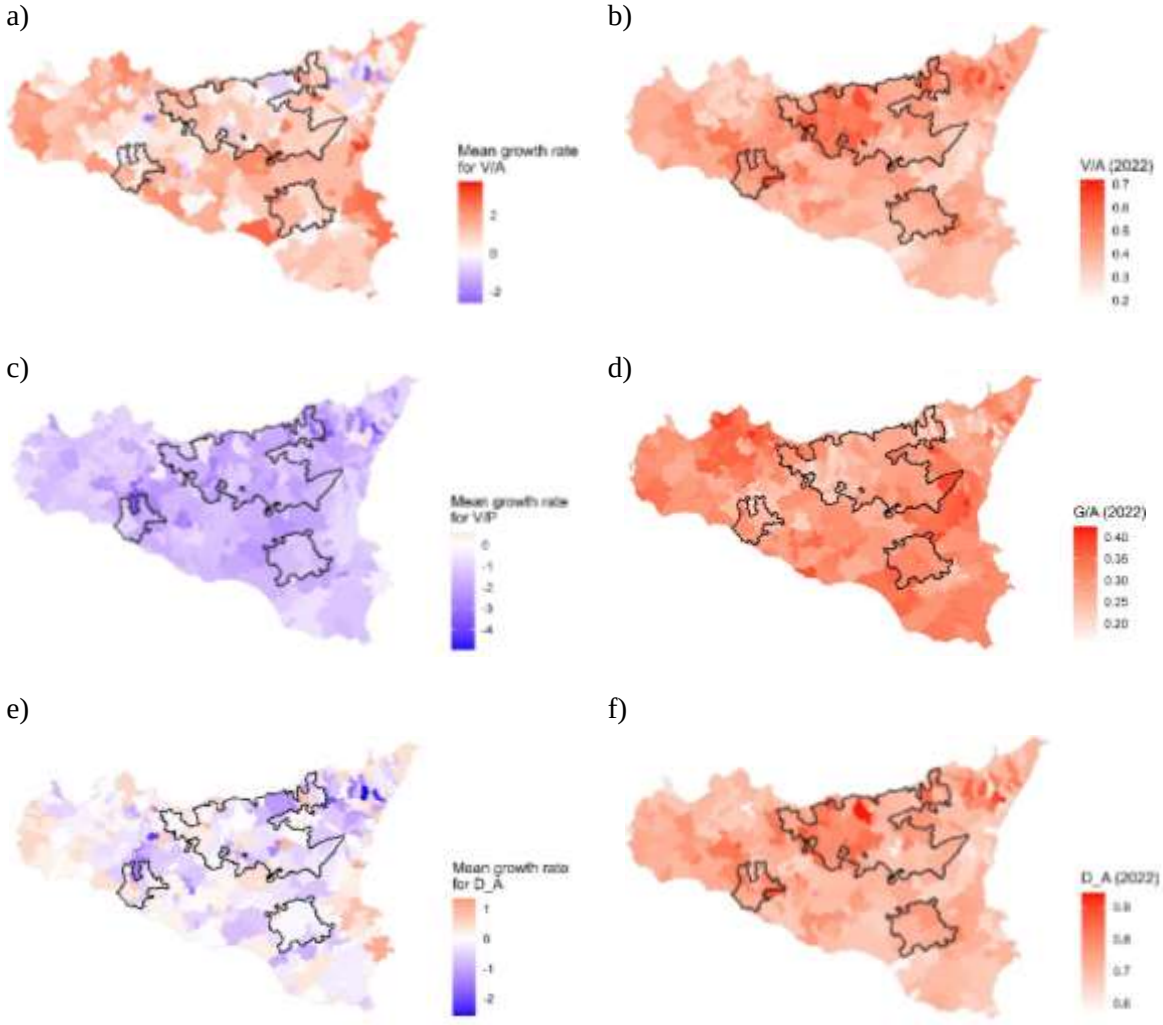

Figure 4 Dependency ratio and its components (as mean growth rates between 2002-2022 in subfigs.4.a-c-e and as annual values in 2022 in subfigs.4.b-d-f) in Sicily. Note: G = population aged [0,19]; A = population aged [20,65); V = population aged [65+); Dependency ratio: D_A = V/A + G/A. PAs contoured by black solid lines. Source: authors' elaboration on Istat and NSIA data.

Roughly speaking, the lower proportions of young people (G) and the higher proportions of old people (V) over the working-age individuals (A) emerging in IAs (and PAs in particular) indicate the efficacy of the current NSIA classification. Yet, looking at the left-hand side maps, the situation becomes more complex. Indeed, the variation over time of the same indicators illustrated for 2022 configures a multifaceted situation where the increasing burden of elderly over working people and the youngsters drain appear heterogeneous. Indeed, the areas characterised by an average increase in the demographic burden do not always correspond to the PAs selected among the IAs identified according to the current methodology. This consideration is also confirmed by comparing the mean growth rates (2002-2022) of selected dependency ratios between IAs and PAs, grouped together respectively (Table 3). The proportion of elderly over the total population, adults and young people has increased (on average) more in IAs than. On the other side, the proportion of those aged [0,19] has decreased, in mean terms, more in IAs than in PAs.

Table 3 Comparison between the mean growth rates (2002-2022) of selected dependency ratios between IAs and PAs. Note: P = total population; G = population aged [0,19]; A = population aged [20,65); V = population aged [65+). Source: authors' elaboration on Istat and NSIA data.

Mean growth rates (2002-2022)	Inner areas	Project areas
V/P	0.974	0.841
V/A	0.876	0.752
V/G	2.262	2.163
G/P	-1.375	-1.408
G/A	-1.474	-1.495

Overall, the depopulation processes occurring in Sicilian IAs have been causing two demographic trends: the first is the aggravation of the demographic burden of elderly over working age individuals; the second is the shrinking of the young age classes, those which can contribute the most to the future socioeconomic vitality of IAs. The ongoing demographic dynamics induce future social, economic and cultural changes, which are worthy of attention. A crucial aspect that should be addressed pertains to the examination of the labour force potential that each area will need to confront the emerging challenges in the forthcoming decades (Blangiardo, 2013).

According to the potential demography the future of a population can be considered as an economic asset and a population possessing more future years can be considered wealthier (Blangiardo & Rimoldi, 2012). The assessment of a population's future is determined by calculating its "potential years of life" (PYL), a measure firstly introduced by Hersch (1944). PYL is the sum of life expectancies of all its members. During a year, PYL increases through births and net migrations, while it decreases by the simple "consumption" of the remaining years of life (due to time flow) and by deaths (Blangiardo, 2012). Hersch's fundamental idea was straightforward. For an individual of a specific age x, their PYL are represented by the life expectancy, e_x (Panush & Peritz, 1996) If the age distribution of a population is given by P_x, then:

$$PYL = \frac{1}{2}\sum_{x=0}^{100+} P_{x(e_x+e_{x+1})} \tag{1}$$

The PYL can be broken down in several meaningful ways. Thus, following the indication of Panush & Peritz (1996), the PYL spent in the working life ages is:

$$PYL_W = \frac{1}{2}\sum_{x=20}^{64}\left[P_{x(e_{x:\overline{65-x}}+e_{x+1:\overline{65-x-1}})}\right] + e_{20:\overline{65-20}} \cdot l_{20}\sum_{x=0}^{19} P_x L_x^{-1} \tag{2}$$

where $e_{x:\overline{65-x}}$ is the expected number of years lived before age 65 by a person now aged *x*. The PYL can be seen as the years of life which the present population is likely to experience some time in the future. The mean growth rate for PYL_W at the municipality level in 2002-2022 is illustrated in Figure 5. Quite all the Sicilian municipalities have experienced a decrease in PYL_w on average during the time period considered. Among them, the areas registering the largest loss are mainly located in the northeastern mountainous regions of Mt. Etna and Nebrodi, and in some inland regions in North-West and South-East. Not all of them are included among the PAs.

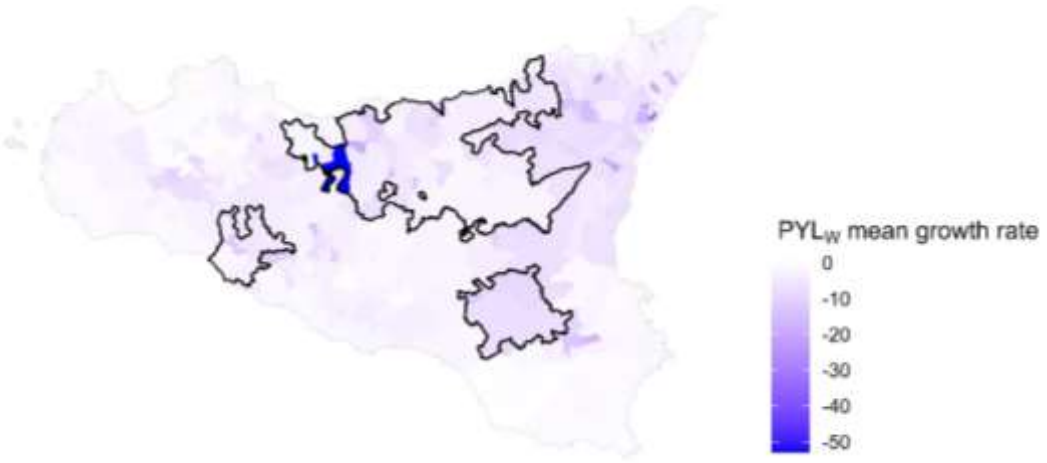

Figure 5 Mean growth rate for PYL_W at the municipality level during 2002-2022. Note: the considered population age classes for the PYL_W computation are [0,19] and [20,65]. Source: authors' elaboration on Istat and NSIA data.

This preliminary, and still partial, picture of the demographic distress of Sicilian IAs is intended as a means of discussion and contributes to the debate on NSIA classification with the final scope of effectively allocating resources to the more deprived and marginalised areas of Italy.

4. Results

To provide an alternative classification for Italian IAs we selected 15 indicators referring to the two thematic areas as defined in section 2 (Table 4). In the first area, variables related to accessibility to transport infrastructure and opportunities in terms of physical and digital services were considered. In the second area, socio-demographic and economic indicators were grouped together.

Table 4 Selected indicators for the IAs reclassification procedure.

Indicator	Source
Population younger than 65 in 2019 (%)	Elaboration on ISTAT data
Demographic balance between 2010-2020 (%)	Elaboration on ISTAT data
Mean migratory balance 2010-2018 (*1000)	Elaboration on ISTAT data
Potential population attainable in 45' of travel	Elaboration on ISTAT data
Highways – distance from the nearest ramp	Elaboration on ISTAT and OSM data
Silver train station with Intercity trains (distance)	Elaboration on ISTAT and OSM data
Airport (distance)	Elaboration on ISTAT data
Port (distance)	Elaboration on ISTAT data
Access to urban centres with at least 50,000 inhabitants (distance)	Elaboration on ISTAT data

Hospital (distance)	Elaboration on ISTAT and Italian Health Ministry data
University (distance)	Elaboration on ISTAT data
Percentage of ADSL connections over total internet connections (ADSL and fiber)	Elaboration on AGCOM data
Percentage variation in local unit (2012-2019)	Elaboration on ISTAT data
Percentage variation in employees (2012-2019)	Elaboration on ISTAT data
Per capita work income in 2019	Elaboration on ISTAT – ASC data

The PCA was performed using the R software (R Core Team, 2023). A preliminary analysis was carried out using the *prcomp*() function, which involves the standardization of the variables. This initial step allowed testing the semantic coherence of the chosen indicators and identifying two components for each area. The decision to extract two components was made because they account for the 0.69 of the explained variance in area 1 and 0.64 in area 2. Additionally, the eigenvalues of the two components are greater than 1, and the scree tests have also supported the choice of two components. Subsequently, we proceeded with axis rotation (Di Franco, Marradi, 2003, pp. 90-97) to allow for a more interpretable solution, as the variables will tend to load heavily on a single component. To achieve this, a new process was carried out in the R environment on the same variables, using the *principal*() function from the "psych" package. The variables were standardized, the varimax rotation method was applied, and the extraction of two components was requested. From the analysis of the rotated components, we derived the component scores. These are vectors consisting of values attributed to each case (individual municipality) concerning each derived rotated component. These values are standardized, thus having a mean of 0 and a variance of 1. Within both of the two PCAs, the same orientation was maintained for all the indicators. The component scores in the two areas follow the same orientation. In those related to the components of area 1, higher values correspond to more elevated peripheral conditions. On the contrary, in area 2, lower values indicate worse conditions. The value 0 corresponds to the mean. A score has been assigned to each municipality based on whether their component scores for each rotated component were above or below the mean (0). For area 1, one point was given for each component to municipalities with values above the mean. For area 2, two points are assigned to municipalities with values below the average in the first component (socio-demographic and labour context) and one point in the second component (economic vitality), as shown in Table 5. The choice to assign two points to the socio-demographic and labour context component aims to give greater weight to demographic aspects, which are at the heart of the debate on IAs.

Table 5 Procedure followed to assign the scores after PCA.

Component	Area	Component score	Score assigned
Infrastructural accessibility	Area 1	Above the mean (component score > 0)	1
Opportunities accessibility (physical and digital services)	Area 1	Above the mean (component score > 0)	1
Socio-demographic and labour context	Area 2	Below the mean (component score < 0)	2
Economic vitality	Area 2	Below the mean (component score < 0)	1

The scores were summed up to obtain a total between 0 and 5 for each municipality. The score of 0 is assigned to those municipalities that are not in distress, compared to the average, across all components. A score of 5 corresponds to the maximum level of peripherality on all four aspects. The municipalities were grouped into classes as shown in the following Table 6 based on the obtained score.

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Table 6 Description of the municipality's categories based on the assigned scores.

Score	Description
0	Non-peripheral municipalities
1	Municipalities with a low degree of peripherality
2	Municipalities with a medium degree of peripherality
3-4	Municipalities with a high degree of peripherality
5	Municipalities in distress for all the components

From the scores, the cartography in Figure 5 was derived. The cartographic representation of the five categories allows for an immediate understanding of the areas facing greater difficulties and those that are not peripheral.

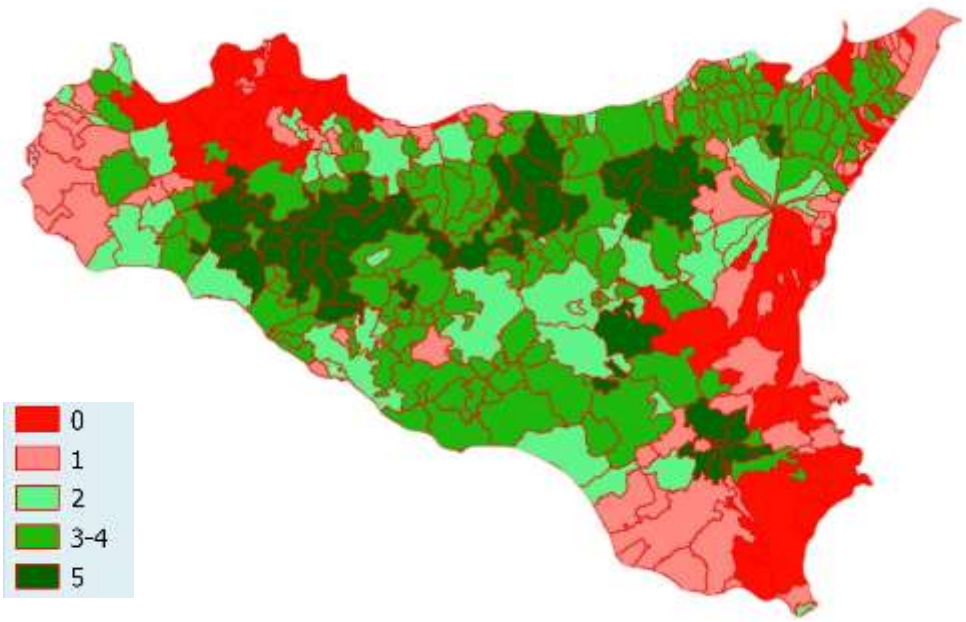

Figure 5 Reclassification of Sicilian IAs. Source: authors' elaboration.

5. Discussion and conclusions

The reclassification of Italian inner areas, particularly focusing on Sicilian municipalities, has provided a more nuanced representation of the phenomenon, going beyond the traditional approach of the NSIA. The NSIA model, while effective in its simplicity and focus on essential services, has overlooked critical factors such as demographic, economic, and infrastructural accessibility differences that significantly impact development policies in these territories. Through a comprehensive analysis of indicators related

to accessibility to infrastructure and services, as well as the demographic and socioeconomic context, we have identified a more detailed division of areas compared to the NSIA classification. This new classification method considers a greater number of indicators and provides a more precise understanding of the challenges faced by individual municipalities. The demographic profile of Sicilian municipalities has been highlighted as a crucial aspect that needs to be considered in the identification of areas suffering from population drain. By analyzing the dynamics of population growth and age distribution over time, and the PYL in working ages, we have demonstrated the complex nature of demographic distress in different areas. The consideration of such dynamics can lead to more targeted and effective intervention plans. The reclassification presented in this study is intended as an alternative to NSIA, rather than a competitive model. By providing a different theoretical premise and a more comprehensive set of indicators, our approach complements the NSIA model and can serve as a valuable tool for policymakers. The categorization into different levels of peripherality helps in developing targeted intervention plans, addressing the specific challenges faced by each municipality. The results of the reclassification have been represented cartographically, making it easy to visualize the areas facing greater difficulties and those that are not as peripheral. This visual representation can aid policymakers and stakeholders in identifying priority areas for investment and development initiatives.

Overall, this study contributes to the ongoing debate on how to effectively support and revitalize inner areas in Italy, and it emphasizes the importance of taking into account various factors beyond the provision of essential services. By adopting a more comprehensive approach, we can develop better-informed policies that address the unique needs and challenges of different municipalities, ultimately fostering sustainable development and minimizing wasteful efforts. As a final note, it is essential to recognize that regional contexts may vary significantly, and the proposed reclassification should be adapted and validated accordingly for other regions in Italy and beyond. Continued research and refinement of such classification models will be essential to ensure that development policies are well-tailored and effective in supporting the growth and well-being of all communities across the country.

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